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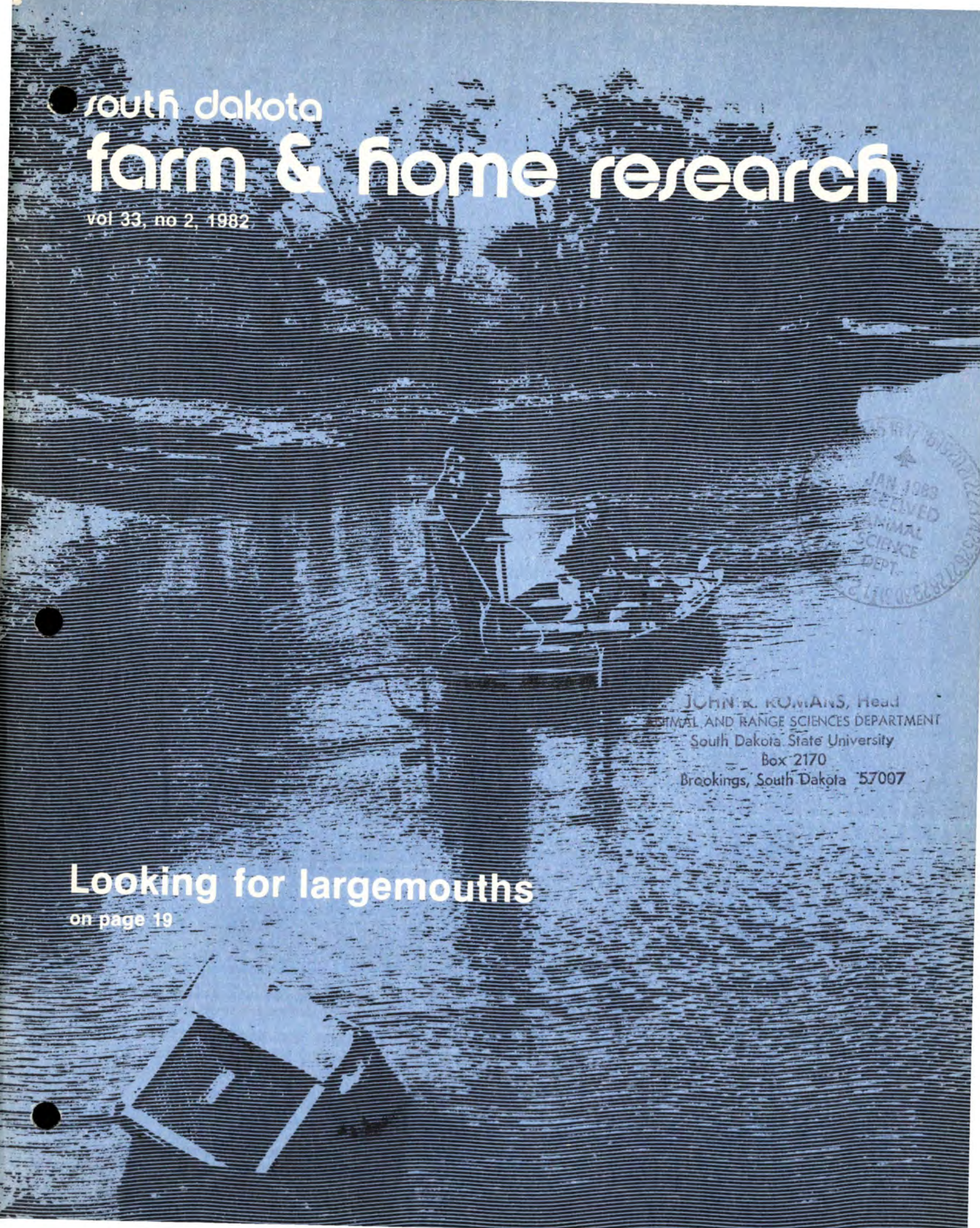
South Dakota Farm and Home Research

South Dakota State University



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Looking for largemouths

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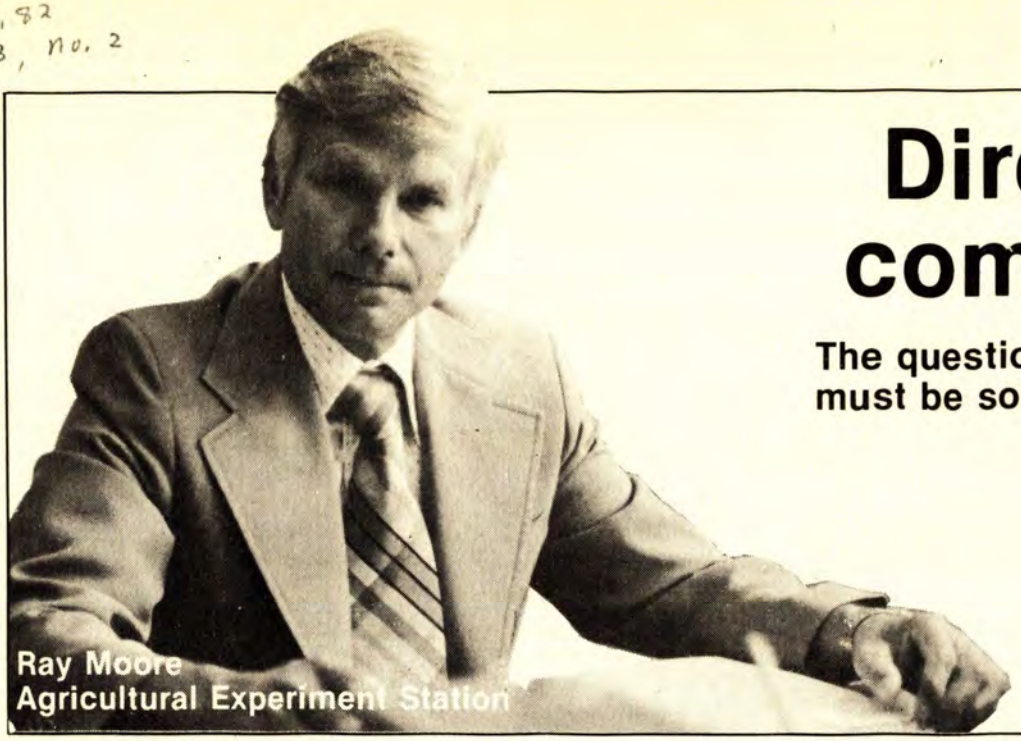


Ray Moore
Agricultural Experiment Station

Director's comments

The questions pile up; most must be solved 'on location'

More irrigation means more questions. Each year more permits are issued and more wells are dug. More water is taken from the Missouri lakes for irrigation. More questions need answering.

The Experiment Station has conducted irrigation research since 1951. The effort was small then, in fact, just 4 acres near Brookings. It's grown to our present 96-acre Ag Engineering Research Farm, where both dryland and irrigation research are conducted.

Additional irrigation answers have been coming from a 200-acre leased farm near Redfield for about 30 years. For many years, the sole source of water was from the Jim River, but now there's a well to supplement the river during periods of low water volume. Irrigation studies have also been conducted at the former USDA field station at Newell, at the Shadehill Project near Lemmon, and at additional locations throughout the state in cooperation with private farmers.

It would seem that we should have the answers to many problems. The truth is that differences in quality of water and the soil to be irrigated are about as numerous as the farmers who would like to irrigate.

Water quality varies from excellent in the Missouri River down to completely unsuitable in some wells. Similarly, soils also differ in their chemical elements and in their drainage profiles. These two major considerations, soil and water, must be studied separately and together, and then correlated with (not even naming all factors):

growing season
mean temperature
frost-free days
natural precipitation
choice of crops
internal drainage
fertility
insects and diseases
standard cultural practices
salinity problems
effects on environment
irrigation equipment
irrigation scheduling
farm machinery design
and economics research.

Only a small amount of irrigation research can be carried out in laboratories and greenhouses. Most must be conducted where the soil and water are located.

A group of producers along the Missouri River recognizes this, and they are seeking funding to acquire land for a new irrigation station along the River. This group has been incorporated into the Dakota Lakes Irrigation Research Farm. The Experiment Station has agreed to lease the land and conduct research on the site when the land is obtained, water is delivered to it, and a building is erected to house a rough field laboratory. The success of this effort is important to obtain needed research information for this rather large, potentially irrigable area in central South Dakota.

Profile with potential

He's 43, a family farmer, been in the hog business 18 years, wants to expand

South Dakota is one of the top ten hog production states with about 3 million hogs and pigs marketed and 3.2 million hogs slaughtered in the state each year. This totals 3-4% of the nation's hog supply. With ample supplies of available land, labor, and feed grain there is considerable potential for further growth of the South Dakota pork industry. However, expansion must be based on profitable production and marketing prospects for producers. The decision to increase pork production is influenced by limits at both the individual and industry level. If those factors can be overcome, South Dakota could advance to an even higher ranking in the pork industry.

In 1980, a pork marketing study was initiated by SDSU to obtain current information on the organization of hog production and marketing in South Dakota, the relative importance and use of specific marketing methods and market channels by South Dakota pork producers, and producer assessment of major factors limiting expansion of hog production on their own farm and in their local area.

This study was aided by the South Dakota Pork Producers Council which printed and included the survey in a newsletter mailing to members. Almost 600 South Dakota hog producers completed the marketing survey.

Those who answered were located throughout South Dakota, but were concentrated in the southeastern and east-central regions of the state. Farrow-

finish, finish only, feeder pig, and breeding enterprises all were represented among those who responded. Respondents represented 5% of pork producers in South Dakota and had larger-than-average size hog operations. In fact, they marketed 11-12% of all hogs sold from South Dakota farms.

The typical respondent was a family farmer, 43 years of age, with 18 years of continuous pork production experience, and had completed high school (Table 1). He marketed 450 head of hogs and pigs annually, and more than 40% of his total farm sales was from hogs and pigs. He raised most of the feed grain fed to his hogs. About 80% of the respondents maintained a farrow-to-finish enterprise, with many also selling feeder pigs and raising breeding stock.

Large-volume and highly specialized operations were fairly common in the sample. For instance, 45% of hogs and pigs sold were from farms selling more than 1000 hogs and pigs annually. A sixth of respondent farms were highly specialized in hog production, receiving 75-100% of total farm sales from the hog enterprise.

Overall, respondents were committed to hog production as a major farm enterprise. In most respects, they represented the mainstream and cutting edge of the South Dakota hog industry today. Because of this, their report of existing marketing practices and perceptions about future prospects for their industry provides valuable insights about this major South Dakota industry.

Table 1. A typical hog producer in the survey was at the leading edge of the industry.

Characteristic	*Median*
age (year)	43.0
Education levels (years)	12.0
Years of pork production	18.0
Annual number of hogs and pigs sold	450
Hog and pig sales as proportion of total farm sales	40%
Dollar volume of hog and pig sales	$47,000

More producers used terminal markets but more hogs went directly to packers

The most frequently used market channel for slaughter hogs was the terminal market. About 44% of the respondents sold some or all of their slaughter hogs through the terminal market. However, a greater volume of slaughter hogs were marketed directly to a packing plant (Table 2). Larger-volume hog producers (obtaining a majority of their farm sales from hogs) were more likely to sell directly to a packing plant.

Terminal markets and auction markets were used by many producers to market smaller numbers of hogs. Order and packer buyers were used by a fourth of respondents.

About 38% of the respondents used more than one market channel during the year. Younger respondents with higher levels of education tended to use multiple channels. The most frequently used market channel combinations were

Table 2. Many respondents use more than one slaughter hog market channel.

Market channel	*Percent of slaughter hogs marketed*	*Percent of respondents using market channel**
Packer-direct shipment	36.5	38.0
Terminal	29.0	44.2
Auction	14.6	37.6
Buyer (order or packer)	18.0	24.7
Other	1.9	2.5

*Percent equals more than 100 due to multiple use of channels.

terminal-packer, auction-packer, and auction buyer.

More than 90% of the slaughter hogs were marketed from 200-240 lb. About 60% of respondents indicated that marketing their hogs at the "right" weight was the determining factor for selecting marketing dates. Other producers indicated market weight was an important factor, but they also studied daily price behavior to determine the best day of the week to market their hogs.

Liveweight pricing method was used by 75% of the respondents as the only means of pricing their slaughter hogs. A few respondents (4%) used grade-and-yield pricing only, while 20% used both pricing methods. Grade-and-yield pricing was used to market 23% of hogs. Larger-volume producers were more likely to use grade-and-yield pricing methods.

About 75% of the sold or finished feeder pigs were farrowed on the respondents' own farms. Auction markets accounted for half of feeder pig purchases, while direct farm purchases and feeder pig cooperatives each accounted for a fourth of purchased feeder pigs.

More feeder pigs were sold by direct marketing to other farms than any other method. However, auction markets were used by more feeder pig producers to market their pigs. Feeder pig producers were younger, less experienced in the industry, more highly educated, and more specialized in pork production than their farrow-to-finish counterpart.

Producers were asked about their use of futures markets, forward contracts, and cash markets for marketing slaughter hogs. All respondents reported using the cash market. The most important benefits of the cash market to respondents (in order of importance) were uncomplicated marketing method, location of market, known price at time of sale, and satisfactory profits.

A limited number of respondents (2.4%) engaged in forward contracting or used futures markets as part of their marketing plan. The most important benefits of these forward pricing techniques were, in order, assured "locked-in" price, acceptable profits, and planning of swine enterprise is less uncertain.

The main reasons cited by most producers not using forward contracts or futures markets were ranked in the following order: do not produce a large enough volume of hogs to warrant a contract, do not fully understand the complexities of contracting, and prefer to use cash market only.

Lack of facilities, rather than low hog prices, limited expansion

Pork industry expansion, if it occurs, will be based on decisions of thousands of individual producers. Respondents were asked to address various factors that may limit expansion of hog production on their own farm and at the local (county) level. It should be noted that responses were obtained at a time when most producers had been losing money on their hog operation for more than one year.

Nearly all producers (98%) indicated one or more factors were limiting expansion of their own operation. The factors ranked most important by respondents are summarized in Table 3. The cost of replacing or building new facilities was cited by three-fourths of all respondents as a limiting factor and by 39% as the most limiting factor. Family labor availability at peak times was mentioned by one-half of the respondents, although only 15% considered family labor as the most limiting factor.

Surprisingly, low hog prices were only mentioned by a fourth of the respondents, but most of these felt it was the limiting factor.

Cautious optimism was expressed by producers on factors which limit expansion at the county level and on their own production plans.

About 60% of respondents indicated one or more factors were limiting pork production expansion in their county. The

Table 3. The most important factor limiting expansion of operations was building or replacing facilities.

Most important factor limiting expansion	*Percent of respondents*
1. High cost of replacing or building new facilities	39
2. Low hog prices	20
3. Family labor availability at peak times	15
4. Nearing retirement or plan to get out of hog business	9
5. Lack of feed grain production or availability at reasonable cost	9
6. Lack of quality hired management or labor	4
7. Not enough hog marketing outlets	2
8. No limiting factors	2

main limiting factors, in order of importance, were lack of credit for expanding farrowing or finishing operation, hog finishing is not as profitable as other enterprises, and low hog prices.

Lack of feed grain markets, feeder pig supplies, and slaughter hog markets were listed far less often as limiting factors.

Producers were asked about their own hog production plans for the next 1-5 years. Responses are shown in Table 4. About 63% of the producers planned to maintain or increase the size of their hog operations. A sixth of these producers planned enterprise changes by adding a finishing operation to their nursery or by adding a farrowing enterprise.

Only 8% of respondents had made decisions to decrease hog production or get out of the hog business, but more than a fourth of respondents, while still committed to raising hogs, were not certain of their future plans. These producers, mostly young and early middle age, were adopting a "wait-and-see" attitude concerning future profits, prices, and availability of credit.

Respondents' perception of factors limiting expansion was linked to their own production plans and influenced by personal characteristics (especially their age and years of production).

The younger, less experienced producer found that the lack of credit and the cost of replacing or building new facilities were the most important problems facing the industry. A high proportion of these producers planned to expand their operations and found lack of credit to be a critical issue.

Many older, more experienced producers felt that the low price level and lack of profits were much greater problems than the lack of credit. Most of these producers were not planning to expand their own operations, so availability of credit was perceived as less of a problem.

Key to profit might be to make wider use of all market channels

Based on pork producers' opinions in 1980, it appears that an easing of tight credit policies and a corresponding drop in interest rates could spur expansion of the pork industry in South Dakota. However, profitability of the swine enterprise now has a greater significance

Table 4 Most respondents were staying in the business.

Production plans next 1-5 years	*Percent of respondents*
Increase production	28
Remain the same	38
Decrease production	5
Get out of hog business	3
Uncertain of future plans	26

Time set aside for studying the markets will pay off as well as any hours actually spent with the hogs, say Larry Janssen, left, assistant economics professor, and Keven Weischedel, research assistant. Knowledge of alternatives and the flexibility to capitalize on them are the keys.

because of the prolonged period of depressed hog and pig prices. The optimism expressed by those surveyed was mirrored nationally by hog and pig inventories. Though economic losses began as early as 1979, actual swine numbers increased in 1980 and did not begin to decline until late 1981 and early 1982.

Pork producers who survived this latest period of economic turmoil now probably will have a much more skeptical outlook on industry expansion. However, this is the time to begin thinking of pork numbers expansion in South Dakota. Red meat supplies have stabilized, and the pork price outlook—although not extremely good—should enable producers to generate some profit.

This profit-making will have to be supplemented by a more aggressive marketing. Flexibility in choosing different mixtures of market channels and marketing methods could prove beneficial to enterprising producers.

The economic losses which were commonplace from 1979-82 should have provided some insights into the actual cost structure of each individual swine operation. This knowledge of costs could prove helpful when forward and futures contracts are investigated in an attempt to "lock in" profits.

It is also quite possible that the key to profitability might lie in market-channel use. The well informed producer will have to use all markets open to him—from direct sales routes to traditional auction markets—to optimize his returns.

Marketing is as important as production in a pork operation. When the two are considered jointly, more favorable returns should result. □

The writers are Larry L. Janssen, assistant professor, and Kevin Weischedel, research assistant, in the Economics Department, SDSU.

About-face

Young people are still leaving state, but who are these folks moving in?

South Dakota's population numbers did an about-face in the past 10 years following decades of loss, according to Dr. Marvin P. Riley and Ms. Linda Baer, SDSU rural sociology researchers.

The change ended an era during which the state often lost enough people annually to populate a town as large as Milbank and Spearfish combined.

This and other findings appear in a new research circular produced by the researchers as part of a series of examinations of population trends in the state. The research combines information on births and deaths obtained at the State Capitol in Pierre with final results of the 1980 U.S. Census. The population gain in 1970-80 (versus a loss in 1960-70) "is due to a natural increase of births versus deaths," Baer explained, "but we still are losing people because of out-migration, or moving to another state.

"The significance is that our out-migration dropped from 13.6% in 1960-70 to just 4.0% in 1970-80. In other words, our out-migration rate dropped by about two thirds."

The SDSU Rural Sociology Department is part of a consortium of census information processing centers for the 13

north central states and also is a member of the newly formed South Dakota Census Data Center Consortium.

Information generated by this research is extremely valuable to an array of agencies, organizations, businesses, and individuals in the state, Riley said, especially to those with local, county, and state budgeting and planning needs. School budgets, for example, depend heavily on information concerning numbers of youngsters in various age brackets, particularly now that the state no longer has a school census. The availability of certain federal monies likewise depends on numbers of low-income families, numbers of elderly citizens, and overall population totals.

The study represents the latest word on population.

Who are the people moving in? Will they need schools or retirement homes?

The researchers view the results so far as a mixed bag: some is good news, some is bad. The overall state population gain amounted to 24,511 people, or 3.8%. However, it was far behind the national average gain of 11% and only sixth among the seven neighboring states. Wyoming, for instance, had a 42% gain in the past 10 years, the fourth highest in the nation.

The researchers say it is important to note just how that gain was achieved. In former years, slight increases in population were noted just because South Dakota's birth rates helped to offset the number of persons who moved away. Now, even though some persons still are leaving the state, more are moving in—and this reduces the amount of net out-migration.

But answers often just inspire more questions.

"It's important that we find out just what type of persons are moving here to replace those who've moved away," said Baer. "Are they young families? Retirees? Low-income? Or what? And what is this doing to our former totals and averages for these various types of people?

Another major finding is that fewer

South Dakota counties lost population in the past 10 years, compared with the preceding decade. During 1960-70, 53 of South Dakota's 67 counties lost population. From 1970-80, only 44 of 66 lost population.

"...of 66?" Yes, South Dakota also lost a county. The formerly unorganized Washabaugh County, located north of the Martin area, has been attached to Jackson County since the 1970 census was taken.

Losses per county also amounted to smaller percentages than during the prior decade. And while only 14 counties recorded gains during 1960-70, 24 counties gained during 1970-80.

"A new phenomenon occurring in the midwest and South Dakota is that counties with a previous record of consistent population loss are now gaining in population," said Riley. "South Dakota has 14 of these 'turn-around' counties."

Pierre was the leader in "urban place" growth; Brandon and Box Elder qualified

Riley also explained that the federal government places great stock in the kind of label which can be attached to a town or city. Funds such as revenue-sharing monies tend to be influenced by this. "An urban place, for example, is one which is incorporated and has 2500 or more people. With the incorporation of Box Elder, near Rapid City, and Brandon, near Sioux Falls, we now have 24 urban places—a gain of two over the preceding census. However, we also lost one when the population of Chamberlain dipped beneath that level."

For awhile, it looked as if South Dakota would have two Standard Metropolitan Statistical Areas—another such classification. These are places with 50,000 population or more, including adjacent counties functionally related to the central city. One, obviously, was Sioux Falls; the other, Rapid City, was given the SMSA designation in 1978 on a preliminary basis because of projections of population growth over the coming years.

"However, Rapid City and its contiguous area didn't have the head-count to keep that designation when the 1980 census was taken, and I'm sure this will mean the loss of some federal dollars."

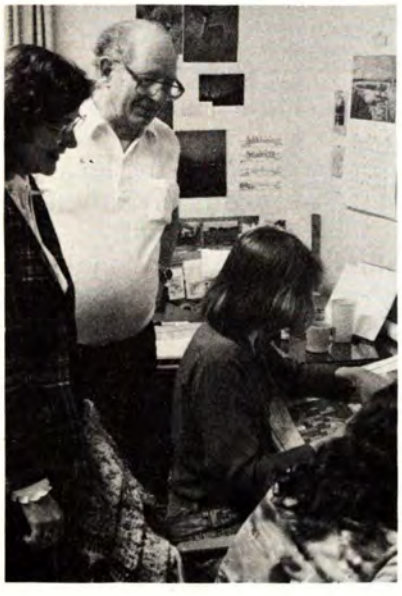
Baer had more to say about urban places.

"It used to be fairly accepted that college towns would have substantially increased growth rates because of increasing college enrollments, but we found only moderate growth in college communities during the 1970's, and some even declined. By contrast, Pierre had the most dramatic growth among urban places—just over 23%. Watertown had nearly a 17% growth, Sturgis about 14%, and Belle Fourche about 11%.

"Clearly, other factors such as growth in state government, an influx of retirees, and proximity to nearby areas of high growth such as Wyoming have become major factors influencing population growth."

Riley added that South Dakota urban places fit roughly into three groups: 10,000 or more population, 5,000-10,000, and those of 2,500 to 5,000. The average growth rates for the two larger fell below what they had experienced from 1960 to 1970. The smallest group experienced only a slight increase. Worst-hit was the second category. Here, the 1960-70 growth rate of 20% plummeted to just 2% during the 1970-80 period. The slight increase of the smaller of the three groups was due primarily to population increases in Belle Fourche and Milbank. The slight decline in the larger of the three matched the 1-2% gain of the smallest group.

Counties in the Black Hills region and those with large cities or located adjacent to large cities received the majority of the



As people move about, the patterns that come up on the maps and the computer screens are intriguing and often puzzling, these researchers say. At upper left are Deb Crotchett, research assistant, and Louise Edleston, student from White River. Watching the patterns take shape are Marv Riley and Linda Baer, rural sociologists. The multi-colored maps depict in- and out-migration in 1175 counties comprising the Northcentral District.

growth. In contrast, seven of South Dakota's urban places actually lost population and the six largest South Dakota cities experienced only low to moderate growth in the past 10 years.

Baer speculates that young people still are the primary group leaving the state. The puzzle is that despite the continuing loss of the young, the population still rose.

"So who are those moving into our

state? This is preliminary, but I suspect some of these people could be retirees returning to their home state after a career elsewhere," she said. "If, in the next phase of our research, we find this to be true, it has some real implications for planners in South Dakota."

Baer says her suspicions would fit with the rise in Black Hills population overall because of its recreation, scenic beauty, and access to urban shopping. Retirees often seek areas like this to settle.

"This could mean our average age is rising faster than the national average," she continued. "The median age in the state increased by 1.4 years from 1970 to 1980, and we already know that we rank third in the U.S. for proportion of older people to the total population."

An older population requires certain types of medical services and extended care facilities. Further, older persons generally have less ability to bear a given tax burden. Coupled with the suspected out-migration of young families, this also bears on the school systems, the transportation system, and the work force so necessary to attract light industry.

Baer believes the trend toward an older population is long-term. "First, we already have a lot of elderly persons, and they are tending to live longer. Second, we still have a very low birth rate, and we aren't apt to have a baby boom to offset this aging trend.

"This is a significant phenomenon, but, again, it goes back to the need for quality planning for what may lie ahead for our state."

Next study: Where are the young people? What's happening to them?

Is there reason for long-term pessimism?

"Actually, no," said Baer. "Big-city population is peaking out, and these people are returning to areas like South Dakota. We could use a little more planning and possibly more light industry to attract some of these younger families. But I'm generally optimistic about midwestern growth, because many people seem to have had enough of metropolitan living."

Part of the apparent out-migration of the young family also is connected to agriculture and the need for larger, more expensive farming units to make ends meet. This keeps many young farmers from entering or remaining in farming. "It could be that agriculture will reach a place where it has an optimum of ag people to support it, and it then will stabilize," said Baer. "But, for now, we still may be moving toward that point because we continue to lose farm families."

"The prospects of an eventual influx of people into the state offer some interesting and useful things to investigate," said Baer. "For instance, what happens when newcomers in a community bring differing beliefs and customs? In other words, how do we prevent cultural clash in an instance like this?

"Also, what do you do when the local population doubles overnight, say, in the event of an oil boom? Do you build schools to accommodate the additional children when you know farther down the road that you might be faced with empty classrooms after the boom?

"Any time population mushrooms, there are problems associated with it, and we have to be prepared for those problems."

Both Baer and Riley announced that the current study is the first in a series. A study of the age and sex structure of the South Dakota population is next. "We want to know where the young people are in both urban and rural areas, and what is happening to them." □

The writer is Larry Tennyson, information specialist in the Ag information Office.

Find her in your own herd

The difference in cow efficiency can be 145 lb more calf on 600 lb less hay

When most ranchers think about cow efficiency and the things that influence it, they usually think about something other than their own herd.

They may consider changing to a larger size or heavier milking cattle or an exotic breed.

Research at SDSU indicates that

important differences in cow efficiency probably exist in all herds.

The measure of cow efficiency used in our research was the pounds of total digestible nutrients (TDN) consumed by the cow for a year and the calf from birth to weaning, divided by weaning weight.

In addition to year effects with their usual large influence, sex and age of calf were important in determining the efficiency of a cow. Surprisingly, age of dam and breed in this experiment were not important.

Further studies indicated that cow weight and cow height accounted for less than 1% of the differences in efficiency, while milk production had an accuracy of approximately 20% and weaning weight 60%.

It was obvious from these data that if a cow herd was culled on the basis of cow weight, the average weight of the herd might change but the efficiency of producing a pound of calf at weaning would not. The results for cow height or frame size were similar to these results for cow weight. That is, there was not any relationship of height to cow efficiency.

These results should not be interpreted as meaning that important differences in cow efficiency do not exist in a herd. The least efficient cow in the SDSU herd required 4½ lb more TDN per pound of weaning weight than did the most efficient cow. The inefficient cow produced a 385-lb calf while consuming the equivalent 600 more pounds alfalfa hay than the most efficient cow which produced a 530-lb calf. This difference of 145 lb less calf and 600 lb more hay consumption does indicate the trait is important.

Accurate predictors of cow efficiency, which might be used at weaning or yearling ages for selection of replacement heifers, are urgently needed. To take advantage of a high predictive accuracy for weaning weight, the cow needs to have a calf so we can measure that weaning weight. The cow's own weaning weight is not an accurate indicator.

Until research develops such indicators, the progeny test of the cow (obtaining a calf before the final selections are made) or selecting bull calves from cows with high-indicated efficiency remain the only choices available.

These choices will be largely practical only in purebred herds. Progress can be made, though, with these techniques, as evidenced by the substantial improvement the dairy people have made in milk production using these same techniques.

In addition, economic evaluations need to be considered besides efficiency of production.

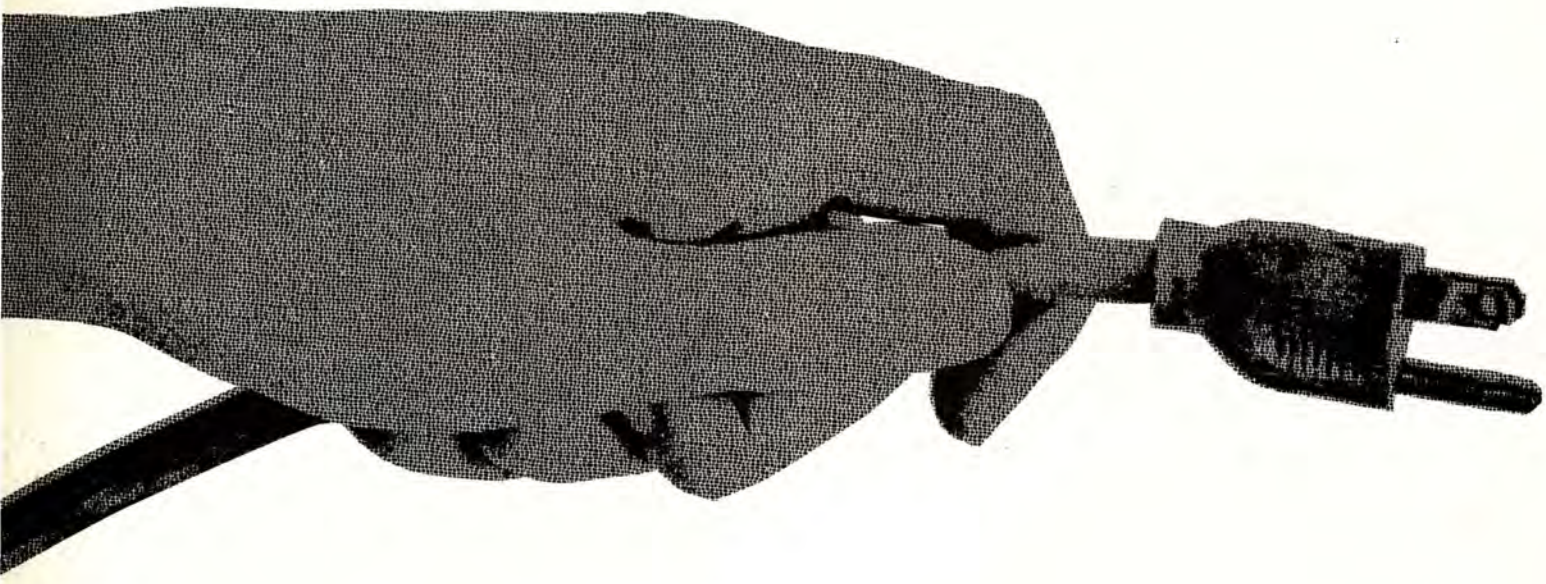
Most current economic evaluations favor larger cows principally because fewer large cows, for the same feed supply, will produce as much or perhaps some more than small cows; and the costs that vary with the number of cows in the herd, such as veterinary, etc., are large enough to tip the balance.

This assumes, of course, that the cows are larger because of selection for early growth and, therefore, will raise calves that are heavier at weaning and will gain faster post-weaning.

It is these kinds of cattle that currently are favored in the market place whether it be at weaning or at slaughter.

There does not appear to be any antagonism between the production of this kind of cattle and cow efficiency. □

The writer is Chris Dinkel, professor of animal science, SDSU.



A tractor for the 90's

Did you put the cat out? Did you plug in the electric tractor?

There may come a time when some farm tractors are "fueled up" with an extension cord instead of a gasoline or diesel hose, according to a team of ag engineers at SDSU.

Les Christianson, Maynard Resen, Ralph Alcock, and five research technicians have worked for about the past 3 years to determine if gasoline and diesel tractors and utility vehicles can be replaced by battery-powered vehicles.

Yes, battery-powered electric vehicles are technically feasible for agricultural use. Furthermore, electric vehicles could operate on 38-53% of the cost and would be more economical on a life-cycle basis compared to conventional farm tractors, based on projected improvements by 1990.

Christianson, project leader for the team, delivered these and other findings at a Baltimore, MD, symposium sponsored

by the Electric Vehicle Council.

The work has shown that fully 50% of the field tasks and nearly 100% of the livestock and utility tasks on the farm—expressed in terms of required energy—could be accomplished by using one properly designed electric vehicle sized to provide 60 horsepower for 4 hours on one electrical charge per day.

"Using current electric vehicle technology and energy prices, electric vehicles already are within 5% of the best conventional farm vehicles in terms of usable power output," said the engineer.

Plenty of reasons to look at electric tractors right now

Work to date has been in five steps. First, vehicle requirements were determined for performing agricultural tasks as functions of operation size and the type of farming enterprise. Second, hypothetical electric vehicles were designed according to these agricultural requirements.

The third step was to analyze the technical feasibility of using battery-powered electric vehicles for farm use. Fourth, the team put pencil to the idea to see whether it would be economically feasible now and 10 years from now. Last, the group identified the circumstances which could possibly spark the interest of farmers in electric vehicles.

"Farm vehicles consume 3% of the total annual U.S. energy diet," said Christianson. "This represents an important segment of the vehicle market, and it has received little attention from electric vehicle producers."

What was the spark that made Christianson and his colleagues believe there was potential to the idea, and that they weren't just chasing down a blind alley?

"Well, there are at least a half-dozen reasons why we thought we were on to something.

"First, you need to take a look at the type of use that tractors get. A large number of farm tasks must be performed daily, the year around, and for short durations. And most farm tasks are performed nearby—somewhere around the yard. A lot of these farm tasks are stop-and-go, just like city driving, and they are inefficient for internal-combustion engines.

"Second, you have to realize that most farm operators are pretty handy people from a technical and mechanical standpoint, and this makes them particularly capable of adopting a new technology like this. Another factor is that nearly all farms and ranches have more than one tractor, so the electric tractor doesn't have to be perfectly suited to every single task—a diesel tractor could handle those which the electric tractor couldn't.

Third, you need to look at the times. .. The price of fuel and the periodic threat to supply make farm operators particularly vulnerable, and the result has been that farmers have been highly interested in any alternative to problems like those associated with conventional farm vehicles."

When the work first began in 1979, the team began to analyze the requirements for performing farm tasks. They looked at the research on 14 performance characteristics, including power range, ground speed range, maneuverability, and others. They then picked 17 Brookings-area farming operations to obtain and analyze hourly machinery use records during the following 2 years. They also obtained in-depth opinions of vehicle requirements from the farm operators. All this data was then charted to show the vehicle requirements for specific agricultural tasks ranging from general utility work to heavy tillage for farms from under 200 acres to over 1,000 acres in size.

The reason for all this preliminary

This is no "blind alley," Les Christianson, ag engineer, and his co-workers say. "If the most likely energy scenario proves true, electric vehicles definitely will be feasible in 1990."

work, Christianson explained, was that previous research implicitly assumes the use of internal combustion tractors, and that farming itself has evolved around gas and diesel-powered tractors. The trouble comes in the two major differences between internal combustion and electric tractors—an electric motor feature which allows the vehicle to temporarily overload without stalling, and the cost of on-vehicle energy storage on the electric vehicle which makes excessive battery capacity unfeasible.

When this early phase was over, Christianson and his team had 50,000 measurements of vehicle performance to sift and consider. The outcome was that five kinds of performance were identified as most critical for comparing electric farm vehicles with conventional power, speed, draft, daily operating duration, and annual operating duration.

The next step was to take a look at present electric vehicle potentials for agricultural use and to define an electric vehicle which could result by 1990.

The team found that all tasks currently performed by internal combustion vehicles on farms already could be performed by battery-operated electric if practicality and economics weren't considered. Weight and cost of batteries sized for maximum operating duration would be too great, however. Also, the tractor would weigh so much that both rolling resistance and soil compaction would become a problem in field work.

The team found that only about 20% of all farm tasks require more than a 60 horsepower tractor or last more than 4 hours, and that these remaining tasks require up to 100 horsepower for periods of 12 hr or more. They also recognized that there isn't much need for tractors smaller than 15 horsepower on most farms today. For these reasons, the team selected electric vehicle sizes of 15, 25, 40, and 60 horsepower for hypothetical vehicle designs.

"These sizes appear to have the best economic potential between 1980 and 1990," Christianson said.

The hypothetical designs were based on interviews with electric vehicle manufacturers, reviews of related technical literature, and study of the U.S. Department of Energy's comprehensive analysis of current and future electric vehicle capabilities. Specifications were drawn for both lead-acid batteries and nickel-zinc batteries as optional power sources.

The team then applied the design to five types of farm work—heavy field, medium field, light field, livestock, and utility—to determine what percentage could be done by electric vehicles of the four sizes specified.

In 'most likely' 1990 energy picture, electrics will be 'definitely feasible'

The next step was to measure the economics.

Christianson interjected that farm

vehicles consume just 3% of the nation's energy diet and that "...while this may not sound like much, it comprises more than 1.3 billion gal of gasoline and 3 billion gal of diesel fuel for these five kinds of work for the year 1978. Besides this, another 2.1 billion gal of gasoline and 6.8 million gal of diesel fuel were used in cars, trucks, and pickups operated in conjunction with farm operations for that year.

"The point is, replacing a percentage of those tasks with cheaper power represents a huge amount of energy and cost savings."

The engineer said that to consider the economics, one has to make some assumptions.

"Electric rates will rise, and so will the costs for petro-fuels. Both electric and petro-fueled vehicles will improve in efficiency and rise in purchase cost during the next 10 years. You also have to consider how long these respective vehicles will last, how easy they are to maintain and operate, the amount of pollution, how important it is to reduce our energy vulnerability, and even what effects may result from government policy through taxation, rationing, interest rates, and other factors," he explained.

To cover the bases, Christianson and his team "bracketed" some of the factors. They projected fuel costs, for instance, on an "optimistic," "most likely," and "pessimistic" basis over the next 10 years. They compared electric and petro-fueled farm vehicles on the basis of some improvements and no improvements in efficiency over the next 10 years.

"We can say at this time that if the most likely energy scenario for electric vehicles proves true, electric vehicles definitely will be feasible in 1990," said the engineer.

Other factors are a little more difficult to assess, but most appear to favor electric vehicles over conventional farm tractors. "Electric vehicles last longer, require less maintenance and have less down time, are easier to start, have the advantage in pollution, are less noisy, and produce no dangerous gases when operated in closed areas. Electricity is inherently more versatile than petro-fuel because it can be generated from any energy source. Government policy is hard to predict, but it appears that the desire for energy independence and the relative abundance of coal and nuclear fuels within the United States will cause government policy to favor electric vehicles," he said.

Christianson sees three possible factors ahead which could hasten the development and acceptance of electric farm vehicles.

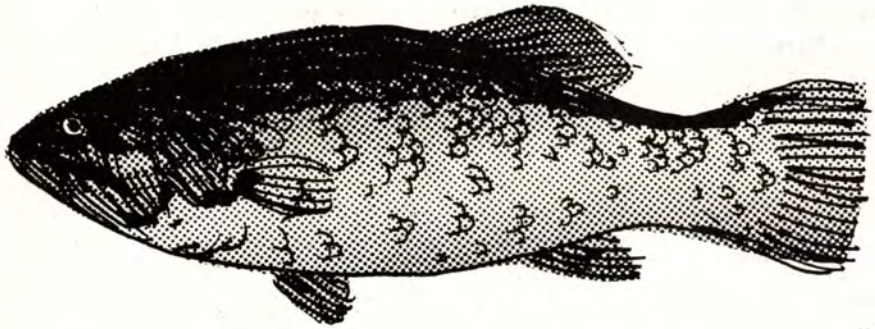
"Interruption of diesel or gasoline supplies by either government rationing or by foreign governments is the most likely," he said. "Even short-term energy supply interruptions can devastate agricultural productivity. Farmers are acutely aware of this, and many already have invested heavily in energy alternatives such as alcohol production.

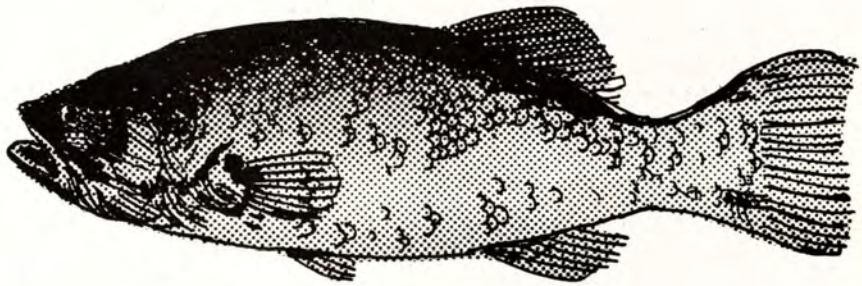
"We also could see a technological breakthrough in the electric vehicle industry which could precipitate agricultural demand. Even achieving the modest technological improvements we have projected would offer a sizable cost advantage to farmers.

"Electric utility companies also could have a large effect by offering special off-peak electric rates for re-charging electric vehicle batteries. This alone could cut the costs we used in our projections by as much as 50%. And if only one charge per day is used—as we have assumed—this could just as well occur during the off-peak period.

"We're on our way, and the future looks promising for this new technology," Christianson concluded. □

The writer is Larry Tennyson, information specialist in the Ag Information Office.





Largemouths in farmponds

Can't fool our local bass with a 'southern' stocking formula

The largemouth bass. While he's not the official state fish, he's nothing to sneeze at either. Many anglers are glad to find him on their line when fishing in one of our state's ponds or shallow lakes.

Because he is a desirable catch and grows well in shallow waters, the largemouth bass is the subject of an SDSU project. The Department of Wildlife and Fisheries Sciences is working out the optimum fish combination for stocking farm and ranch ponds in South Dakota. Several species of prey fish are being evaluated to see which results in the greatest growth and production of largemouth bass.

A stocking formula specifically for South Dakota ponds is needed. Biologists realize the geographical area of the country has an important impact on fish populations. No longer are the bass-bluegill combination and stocking rates developed in southern states recommended for the northern regions. Length of growing season, minimum temperatures, fishing pressure, and soil fertility are all factors influencing species compatibility.

A good population of largemouth bass needs a sufficient number of small prey fish. Without adequate forage, largemouth bass feed on their own young, keeping a desirable size distribution of bass from developing. An additional disadvantage is that intense competition for food among fish of the same size stunts their growth.

Because they've been unsuccessful with a bluegill and largemouth bass combination, many South Dakotans have elected to stock only bass in their ponds. As a result, they've ended up with a single, large year class of small bass—and few fish over 2-3 lb.

Sixty ponds throughout the state were stocked with largemouth bass and either bluegills, black bullheads, golden shiners, or fathead minnows to find the best combination. As a control measure, 20 ponds were stocked only with largemouth bass.

Bass put on more length in the south; fathead minnows were good starter diet

To determine how effective each of the prey species are, populations and growth rates of the bass were evaluated. Last spring, we seined the study ponds in the southeast corner of the state. The netted bass were measured, marked by a hole clipped in the caudal fin, then released back into the pond. A few days later fish were again collected in these ponds, this time with an electrofishing boat.

SDSU's is a 16-ft flat bottom boat with an electrode system suspended from booms at its bow. Electrical currents which pass between the electrodes produce an electrical field which disables fish temporarily.

By determining the proportion of marked fish which are disabled to the unmarked disabled fish we can estimate population size. During the summer, we used the boat to measure bass growth rates in the remainder of our study ponds.

After one year, we could see differences in growth of the largemouth bass both among geographical regions and stocking combinations.

In the northern half of the state, bass grew from an initial size of 1.5 inches to 5.5 inches, compared to 6.7 inches in the south. Variations in length of growing season accounted for most of this difference.

Among different stocking combinations, however, bass stocked with fathead minnows were up to an inch longer than bass stocked with other prey species. This looks encouraging, but other studies suggest fathead minnows are eliminated by bass within a few years after initial stocking. The value of stocking fathead minnows with other prey species appears to be that they serve as starter forage to improve initial growth rates of bass.

Bass don't spawn till the third year, meaning: hold back on fishing pressure

Survival rates are a concern for biologists studying stocking combinations. After one year, survival rates of largemouth bass ranged between 50-100% in ponds with adequate depth (12-15 ft). Bluegill survival averaged just 29%, whereas 68% of the bullheads survived.

Survival rates affect how soon and how heavily you should fish a pond in the years right after stocking.

Bluegills and bullheads spawn during their second growing season. Bass generally do not reproduce until the third season following stocking. If a second game species such as bluegills or bullheads is stocked, harvest restrictions on the bass would be necessary to maintain sufficient numbers of larger bass to control surplus production of prey fish. Approximately 12 adult bass per

Somedays it's just nice to be fisheries biologists. One day they seine the pond, measure, clip the caudal fin, and return bass to the pond. A couple of days later the biologists reappear in a boat that's wired for electricity to temporarily stun all fish in range of the booms. The proportion of clipped to unclipped fish will give a population estimate.

acre per year is the fishing limit recommended.

Harvest restrictions are particularly important since largemouth bass are highly vulnerable to fishing pressure.

Work on an optimum stocking combination for South Dakota ponds will continue for a third season. This summer, the reproductive success of bass populations was examined relative to the presence of different prey species. Populations of prey species were also checked to see which are most subject to overpopulation in the presence of largemouth bass.

With a stocking formula developed specifically for our state's ponds, largemouth bass may be on the end of more fishing lines than ever. □

The writer is Timothy C. Modde, assistant professor of wildlife science.

Coming of age

A 4-acre infant 30 years ago, young giant now covers 25,000 county acres

It was 35 years ago. World War II had ended, and most of South Dakota's young men and women had returned home. The age of irrigation was just beginning.

The Pick-Sloan plan would establish six mainstream dams on the Missouri River, and four of these were to be in South Dakota. The intent of the plan was to provide flood control, electricity, irrigation, recreation, and navigation.

To four young men on the campus of South Dakota State, Pick-Sloan meant water and electrical power in adequate amounts for agriculture for the first time in the state's history. It also meant a new and different kind of agriculture, one that called for an enormous amount of agricultural research and preparatory work. They set out immediately to begin filling those needs,

John Wiersma, Larry Fine, Leonard Erie, and Dennis Moe were those young men, and they soon were joined by other researchers including Don Broz, Jack Runkles, and Walt Lembke.

Dr. Wiersma now is director of the Water Resources Institute and a professor of agricultural engineering. Dr. Fine is a professor of plant science and only recently retired from the SDSU faculty. Dr. Moe, who became head of the Agricultural Engineering Department at SDSU, also has just retired. Erie eventually joined the federal Irrigation Lab at Tempe, AZ, where he retired last year.

Broz now is an Extension irrigation specialist at the University of Wyoming. Lembke holds a teaching and research position at the University of Illinois, and Runkles is a soil physicist at Texas A&M University.

It started with just a 4-acre plot; now the county has 25,000 irrigated acres

Moe remembers it well.

"The first irrigation research in Brookings County was in 1948, and the principal investigators were Leonard Erie and John Wiersma, working on land owned by Judge W.W. Knight. It was small-plot research which related sprinkler patterns to wind velocity.

"As I remember, they found that the pattern changes substantially when the wind velocity exceeds somewhere around 12 miles per hour. Strangely enough, this

research remains relevant and useful even today."

The following year, Wiersma worked alone on an extension of this research, eventually using it as his thesis in the Department of Agricultural Engineering. In 1951 the project was moved to 4 acres near campus.

This was the first irrigation research on SDSU soil, Moe said, and about the first irrigation of any size in the entire county. Now, 30 years later, about 25,000 acres of Brookings County land is under irrigation.

The site was adjacent to the present location of an electrical sub-station a short distance north of the SDSU campus on old Highway 77. It was part of an area that had been used for beef cattle pasturage. "We chose this site because it contained a water-bearing aquifer at a rather shallow depth," he said.

Prior to spring 1951, no commercial irrigation well driller existed in the state, Moe believes. A domestic well driller named Grimshaw wanted to become the first, however, and after considerable consultation and negotiation with SDSU officials, he agreed to drill the necessary well on a small plot near the irrigation research site.

Moe says the well was about 60 ft deep and had a 30-inch diameter curbing to produce about 90 gal of water per minute. A later well drilled nearby produced 10 times this amount of water in 1954.

"One problem during this first irrigation research venture was that the water contained so much iron that the corn had brown leaves instead of green," Moe laughed. "We eventually learned that the high iron content of the water originated from the Brookings water treatment plant just across the road."

After 4 years of work at the site, department officials decided the time had come for a permanent irrigation research site. They needed a combination of favorable soil type, shallow aquifer, good water quality, and a location rather near campus.

A 100-acre farm was located about 8 miles southwest of campus and adjacent to the Sioux River.

It was a small beginning, Moe remembers. The Ag Experiment Station contacted owner David Flitte, and negotiated a 3-year lease of 5.8 acres for $20 per acre per year, or less than $120 annually.

Rules called for farm payments in advance, then they could irrigate

By May 1957, a purchase agreement was made with Flitte by the Ag Experiment Station not only for the small tract being used, but also for the remainder of his farm—just under 100 acres.

The contract for the farm was assigned to Moe's department and it was then that the State College Development Association offered a hand. The Association obtained a loan to purchase the farm with the stipulation that the Ag Engineering Department make the payments of $1500 annually—in advance.

"This meant that the Department had to manage the farm in such a way as to make the annual payments to the Association and still provide irrigation research facilities," said Moe. "The Department also had to agree to pay the real estate taxes, have adequate fire and wind-storm insurance, accept responsibility for upkeep of fences and roadways, and provide satisfactory upkeep of the buildings for the superintendent's residence."*

The Department also received permission to annually allocate or sub-rent lands to other Experiment Station departments as needed by them, provided they would not interfere with the

*Mr. Tom Klosterman, superintendent of the irrigation research farm since 1963, continues in that post today after 19 years of service.

irrigation research studies or other operating research projects.

By 1959, the State College Development Association had secured a water permit for irrigation in behalf of the new facility. It was granted on February 24 that year by the State Water Resources Commission, and it specified the use of sprinkler pipe and channel irrigation from a maximum of three pumping stations, including both electric and internal combustion power for the pumping units.

By 1965—10 years later—the farm was paid for in full, Moe said. The State College Development Association then transferred title of the farm to the State of South Dakota for $1. "This again proved the value of the State College Development Association to operate as an intermediary in performing the legal aspects of transactions during the interim period between legislative sessions," said Moe. "Being a non-profit organization, and having the growth and development of state colleges as their highest priority, this organization of persons from the business community of the city and the SDSC faculty rendered some real services in this and other undertakings."

A little of everything—sweet corn, navies, field days—goes on at farm

Moe can list dozens of research highpoints in the years that followed. "We conducted annual or alternate-year field days for hundreds of people," he

A pivot that trickles

A 50% saving in power use, 33% less water could come from trail tubing

One of the newest projects at the engineering farm, with great implications for future irrigated cropping, is Dr. Shu-Tung Chu's project in trail-tube irrigation.

A trail-tube is a perforated poly-flex hose which is connected to the mainline of a center pivot irrigation system to replace the sprinklers.

It's "sort of a traveling trickle irrigation system," Chu explained.

The operating pressure of the system can be as low as 20 pounds per square inch. Standard center pivot systems equipped with sprinklers require about 60 psi, by contrast. The amount of water pressure required to operate an irrigation system relates directly to the amount of electrical energy used.

"The trailing tube system could result in savings of 50% in power use," Chu estimates.

A further advantage is expected in the amount of water used for a given crop. Wind and evaporation are two disadvantages of sprinkler irrigation. The trail-tube would apply water at uniform rates at ground level and would not drench the entire plant in the process of getting water to the root system as in sprinkler irrigation.

"The advantage could be about 33% less water used per crop. This has great implications where ground water is about exhausted."

Chu is working on a prototype of the machine and will begin field trials immediately after development is completed.

said. "Probably the most successful and interesting of these was in 1960 when we had a well driller begin drilling for water at about 10 in the morning. At about 4 in the afternoon, the well was complete, the curbing was in place, and the water was being pumped."

Moe says the research facility has allowed his department to work in many areas including irrigation, agricultural structures, agricultural machinery use, grain drying, solar energy, and specialty crop production.

The Department also has sub-leased land to Horticulture, Agronomy, Plant Science, Plant Pathology, the Extension Service, Foundation Seedstocks, the Water Research Institute, Rural Electrification and Electrical Power Use, and other operational units for various experimental projects.

Specialty crops and like efforts included a 1963 contract with the Utah-Idaho Sugar Company to grow sugar beets and to use certain specialized machines. At that time, the company was contemplating the construction of a sugar refinery in the tri-state area of Iowa, Nebraska, and South Dakota. Although the federal government cleared the way to build the refinery, the company did not follow through on its plans.

Also in 1963, the facility contracted to grow 20 acres of sweet corn for the Big Stone Canning Company of Ortonville, MN. A few years later, navy beans were grown under contract with another vegetable canning company.

"A number of experimental agricultural machinery and equipment items have been used and tested in these projects and some irrigation equipment has been obtained for little or no cost—such as the present 'Little Fielder' center pivot irrigation system," commented Moe.

"As far as that first 4-acre plot was concerned, that was among the first irrigation ventures for Brookings County—with a water right secured in 1954— but it didn't make us the only

Out there, says Dennis Moe, former ag engineering head, lay the first SDSU soil ever irrigated, a mere 4 acres. The water was so full of iron the corn grew brown instead of green. Present site includes this solar collector and wind power generator.

pioneer in irrigation," Moe continued. "In 1956, Tommy Martinson used sand points in the aquifer instead of drilling wells to irrigate 60 acres southeast of Brookings. In 1958, Art Peterson irrigated 40 acres northwest of Brookings. In 1959, Hugh Barnett irrigated 147 acres northeast of Brookings. Both the Whitehead farm near Aurora and the Cunningham farm east of Brookings went under irrigation in 1959 or 1960. The Gilkerson farm, also east of Brookings, was first irrigated in 1967. Lloyd Minor began irrigating south of Brookings in 1969, and A.J. VanderWal started at his farm north of Volga in 1972."

Presently, there are about 1 million acres of water permits in South Dakota, with about 500,000-plus actually being irrigated, Moe said.

"It's been an exciting era to witness," he said. □

The writer is Larry Tennyson, information specialist in the Ag Information Office.

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